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ABSTRACT

Many educators may or may not be familiar with the term constructivism, but probably recognize it as something to do with learning. The main tenet of constructivist learning is that people construct their own understanding of the world and in turn, their own knowledge. This ERIC Digest examines the constructivist view of learning and how it affects teaching, classroom practices, and student classroom behavior. Contents include: (1) "Constructivism in mathematics and science...A contradiction?"; (2) "The basics of constructivism(s)"; and (3) "Constructivism in the classroom". Web resources are also provided. (MVL)

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Constructivist Views of Learning in Science and Mathematics

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Many educators may or may not be familiar with the term "constructivism," but probably recognize it as something to do with learning. The main tenet of constructivist learning is that people construct their own understanding of the world, and in turn their own knowledge. However, any theory of learning has ramifications beyond the scope of learning itself. Simply put, subscribing to a constructivist view of learning affects teaching, classroom practices, and student classroom behavior. Von Glaserfeld (1993) calls constructivism a theory of knowing, as opposed to a theory of knowledge. From his view it is easy to see how constructivism can be thought of as a perspective or a lens with which to understand or know the world; meaning that reality, knowledge, and learning are considered to be constructed by individuals (See von Glaserfeld, 1993 for more philosophical issues regarding constructivism). So what does this mean for educational settings like the typical classroom?

Constructivism in Mathematics and Science... A Contradiction?

It seems as though a belief in a constructivist approach to knowledge or learning is contrary to the fields of mathematics and science, where knowledge is viewed as true facts, principles, theorems, and laws. In literature, however, it makes sense that the reader constructs her own meaning of the works of William Shakespeare or Maya Angelou because she is interpreting the writings and intentions of the authors. But there is only one interpretation of 2+2, and it is 4. There is a danger in trying to apply that logic with mathematics and science because constructivism is not questioning the interpretation of simple arithmetic or the notion of gravity; rather it is saying that each person comes to construct their own conclusions and conceptions. These individually constructed conceptions are personally valued whether they are consistent with what the field deems acceptable or not. A belief that the world is flat is just one particular view. It was once accepted by society, but now is not. Bodies of knowledge including mathematics and science change, and what is claimed to be known in the fields is either a logical derivation from the available conventions, or "the best way of conceiving the situation because, at the moment, it is the most effective way of dealing with it" (von Glaserfeld, 1993, p.33). In fact, some constructivists do not acknowledge that there is a single truth to be known. Instead what is (traditionally) "true" can be thought of as what is viable (von Glaserfeld, 1993.

The Basics of Constructivism(s)

Using the term "constructivism" can be ambiguous because there are several forms of constructivism described in the professional literature. Good, Wandersee, and St. Julien (1993) offer 15 different adjectives to place in front of constructivism to clarify its meaning: contextual, dialectical, empirical, humanistic, information-processing, methodological, moderate, Piagetian, postepistemological, pragmatic, radical, rational, realist, social, and socio-historical (p. 74). While many of these terms relate to overlapping concepts and assumptions, others have distinctions worth mentioning. All forms of constructivism incorporate the notion of individually constructed knowledge. Weak constructivism, as Paul Ernest (1996) describes it, assumes that individuals construct their own knowledge (a local notion), while accepting the existence of objective knowledge (a global notion). Radical constructivism additionally assumes that individual knowledge is in a state of flux, or constant reevaluation by adapting and evolving. In this view, the mind is characterized as problematizing knowledge. Finally, social constructivism is based on the assumption that individual knowledge and social knowledge are one in the same. That is to say that the knowledge an individual constructs is that which he or she constructs with society. This evokes a "shared" metaphor of knowledge, and the "social construction of meaning" (Ernest, 1996, p.343).

Constructivism in the classroom

The various forms of constructivism present different implications when it comes to pedagogical concerns. There are some commonalities, however. According to Paul Ernest (1996) the forms of constructivism identified above all lead to the following pedagogical implications:

1. Sensitivity toward and attentiveness to the learner's previous constructions. This includes using students' previous conceptions, informal knowledge, and previous knowledge to build upon.
2. Using cognitive conflict techniques to remedy misconceptions. Engaging in practices like this allow students to trouble their own thinking, and it is through this conflict that they will develop their own meanings, or at least seek to rectify the conflict.
3. Attention to metacognition and strategic self-regulation. This follows from the previous suggestion when students think about their thinking, and become responsible for their learning.
4. Use of multiple representations. In science and especially mathematics, multiple representations offer more avenues with which to connect to students' previous conceptions.
5. Awareness of the importance of goals for the learner. This awareness of goals refers to the difference between teacher and learner goals, and the need for learners to understand and value the intended goals.
6. Awareness of the importance of social contexts. Various types of knowledge occur in various social settings for instance informal (street) knowledge versus formal (school) knowledge. (p. 346)

In addition to the suggestions proposed by Ernest, Brooks and Brooks (1999) offer five guiding principles of constructivism that can be applied to the classroom.

1. The first principle is posing problems of emerging relevance to students. A focus on students' interests and

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using their previous knowledge as a departure point helps students engage and become motivated to learn. The relevant questions posed to the students will force them to ponder and question their thoughts and conceptions.

2. Another guiding principle is structuring learning around primary concepts. This refers to building lessons around main ideas or concepts, instead of exposing students to segmented and disjoint topics that may or may not relate to each other. "The use of broad concepts invites each student to participate irrespective of individual styles, temperaments, and dispositions" (p. 58).
3. The third principle is seeking and valuing students' points of view. This principle allows for access to students' reasoning and thinking processes, which in turn allows teachers to further challenge students in order to make learning meaningful. To accomplish this, however, the teacher must be willing to listen to students, and to provide opportunities for this to occur.
4. Adapting curriculum to address students' suppositions is the fourth principle. "The adaptation of curricular tasks to address student suppositions is a function of the cognitive demands implicit in specific tasks (the curriculum) and the nature of the questions posed by the students engaged in these tasks (the suppositions)" (p.72).
5. The final principle is assessing student learning in the context of teaching. This refers to the traditional disconnect between the contexts/settings of learning versus that of assessment. Authentic assessment is best achieved through teaching; interactions between both teacher and student, and student and student; and observing students in meaningful tasks.

Brooks and Brooks (1999) offered these guiding principles to serve as over-arching themes for educational settings that are consistent with constructivist learning. They also identify 12 practices that distinguish constructivist teachers. These practices apply to any subject or academic setting.

Constructivist teachers...

1. Encourage and accept student autonomy and initiative.
2. Use raw data and primary sources, along with manipulative, interactive, and physical materials.
3. Use cognitive terminology such "classify," "analyze," "predict," and "create" when framing tasks.
4. Allow student responses to drive lessons, shift instructional strategies, and alter content.
5. Inquire about students' understandings of concepts before sharing their own understanding of those concepts.
6. Encourage students to engage in dialogue, both with the teacher and with one another.
7. Encourage student inquiry by asking thoughtful, open-ended questions and encouraging students to ask questions of each other.
8. Seek elaboration of students' initial responses.
9. Engage students in experiences that might engender contradictions to their initial hypotheses and then encourage discussion.
10. Allow significant wait time after posing questions.
11. Provide time for students to construct relationships and create metaphors.
12. Nurture students' natural curiosity through frequent use of the learning cycle model.

Teachers who embrace the constructivist view of learning are encouraged to compare their classroom practices with those listed above, for they are the indicators that practice matches theory.

For Further Study

ERIC Resources

The ERIC database is the world's largest education-related, bibliographic database, and it can be electronically searched online at: http://ericir.syr.edu/Eric/adv_search.shtml. To most effectively find relevant items in the ERIC database, it is recommended that standard indexing terms, called *ERIC Descriptors*, be used whenever possible to search the database. The term *constructivism* is an ERIC descriptors, so this term could be combined with other Descriptors, such as *science education* or *mathematics education*, in constructing an ERIC search. Such a general search would yield over 140 items.

World Wide Web Resources

Mathematics Education: Constructivism in the Classroom
The Math Forum
http://mathforum.org/mathed/constructivism.html

Constructivism and the 5Es
Miami Museum of Science
http://www.miamisci.org/ph/lpintro5e.html

Constructivism Bibliography
Mathematical Association of America
http://www.maa.org/t_and_l/sampler/construct.html

Essays on Constructivism and Education
Maryland Collaborative for Teacher Preparation
http://www.towson.edu/csme/mctp/Essays.html

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